



# Prevalence of Poor Sleep Quality and its Association with Lifestyle Habits, Competition-Based Activities, and Psychological Distress in Japanese Student-Athletes During the COVID-19 Pandemic

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Sleep Sci 2024;17:e26–e36.

## Abstract

**Objectives** The present study clarified the prevalence of poor sleep quality and its relation to lifestyle habits, competitive-based activities, and psychological distress among Japanese student-athletes in the initial pandemic period (2020) and 1 year later (2021).

**Methods** In the present study, student-athletes were defined as individuals belonging to university athletic clubs. The data of two cross-sectional surveys (2020:  $n = 961$  and 2021:  $n = 711$ ) were collected from student-athletes in 6 universities in Japan. First, the prevalence of poor sleep quality (Pittsburgh sleep quality index score  $> 5$ ) was investigated. Relationships between poor sleep quality and lifestyle habits, competition-based activities, and psychological distress were then explored using multivariate logistic regression analysis adjusted for age, sex, and body mass index.

**Results** The prevalence of poor sleep quality was 33.6% in 2020 and 36.6% in 2021. Poor sleep quality in 2020 was related to late bedtime, taking supplements before bed, part-time job (no late night), stressors of expectations and pressure from others, and psychological distress, whereas that in 2021 was related to early wake-up time, skipping breakfast, taking caffeinated drinks before bed, use of smartphone/cellphone after lights out, stressors of motivation loss, and psychological distress.

**Conclusions** In both 2020 and 2021, one-third of student-athletes had poor sleep quality and psychological distress was its common risk factor. Lifestyle habits and competition stressors associated with poor sleep quality were pandemic-specific in 2020, but similar to the prepandemic period in 2021.

## Keywords

- ▶ COVID-19
- ▶ student-athletes
- ▶ sleep quality
- ▶ lifestyle habits
- ▶ competition stressors
- ▶ psychological distress

received  
October 13, 2022  
accepted  
May 8, 2023

DOI <https://doi.org/10.1055/s-0043-1772811>.  
ISSN 1984-0659.

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## Introduction

The Coronavirus disease 2019 (COVID-19) pandemic has impacted our lives profoundly. In response to the pandemic, each country undertook policy interventions such as lockdown and the state of emergency, which require the avoidance of nonurgent outings, limiting the use of facilities. Online learning became a default in universities, and students had fewer opportunities to go to school and more opportunities to study at home. Student-athletes engaged in competition-based activities were compelled to suspend their sports activities, restricted from using the training facilities, and postponed or canceled the games in the initial pandemic period in 2020.<sup>1,2</sup> Since then, daily practice and competitions have gradually resumed, with the guidance set in consideration of the COVID-19 epidemic and vaccination status, and infection control measures are taken.<sup>3,4</sup>

The pandemic had a greater magnitude of sleep problems in young people.<sup>5</sup> Regarding university students, for example, a study comparing sleep problems in Italian university students before and during the COVID-19 pandemic observed that they had worse sleep quality and more severe insomnia during the pandemic (2020).<sup>6</sup> However, in medical students in Turkey, 33.6% of them had a worsened sleep quality, and 38.6% of them reported improvements in sleep quality, indicating that COVID-19 effects were inconsistent during the pandemic (2020).<sup>7</sup> Another study reported a lower prevalence of insomnia symptoms in Japanese students during the pandemic (2020).<sup>8</sup>

Few studies have examined sleep problems of student-athletes during the COVID-19 pandemic. Only a previous study reported that 92.9% of student-athletes in the United States complained of some insomnia symptoms during the 2020 pandemic.<sup>9</sup> In this study, however, respondents were considered to have insomnia symptoms if they responded “occasionally” or more frequently to any one of the five items of the insomnia subscale in the Sleep Disorders Questionnaire<sup>10</sup>; therefore, the proportion identified as insomniac might be overestimated. Furthermore, few studies have examined risk factors of poor sleep among athletes during the COVID-19 pandemic. For example, a study on student-athletes reported that poor sleep quality was related to > 2 units/day of caffeine (1 unit = 150–250 mL for coffee or tea and 350 mL for caffeinated drinks) under partial confinements with lighter restrictions such as curfews and closures of public spaces.<sup>11</sup> Another study targeting the athlete population, including students, reported that insomnia symptoms are related to poor mental health during lockdown.<sup>12</sup>

However, these studies did not address other factors, such as various lifestyle habits, competition-based activities, and psychological distress, reported to be associated with poor sleep quality of student-athletes before the COVID-19 pandemic.<sup>13</sup> Moreover, the lives of student-athletes have changed dramatically during the 2 years of the COVID-19 pandemic; sleep conditions and relationships with lifestyle habits, competition-based activities, and psychological dis-

stress in student-athletes throughout the COVID-19 pandemic (2020–2021) have not been clarified. Therefore, the present study aimed to determine the prevalence of poor sleep quality and its association with lifestyle habits, competition-based activities, and psychological distress among Japanese student-athletes in the initial pandemic period (2020) and a year after the pandemic began (2021).

## Materials and Methods

### Procedure and Participants

Web-based self-administered surveys targeted students who attended classes for sophomore and junior students in the faculties of physical education of six universities in four Japanese regions were conducted at two time points during the COVID-19 pandemic (May 2020 and June 2021). The number of students who participated in the survey were 2,561 in 2020 and 1,800 in 2021, and the numbers of those who completed the questionnaires were 1,236 in 2020 and 899 in 2021 (valid response rate: 48.3% in 2020 and 49.9% in 2021). Since student-athletes were defined as individuals belonging to university athletic clubs, respondents (961 in 2020 and 711 in 2021) who belong to university athletic clubs were included for analysis in the present study.

The present study was approved by the ethics committee of the Faculty of Health and Sport Sciences of the University of Tsukuba, Japan, in compliance with the Helsinki Declaration (Reference No: Tai 28-5). All respondents provided informed consent to participate in the study by submitting their responses.

### Questionnaires

The questionnaires included anthropometric analysis, sleep quality, lifestyle habits, competition-based activities, and psychological distress.

Anthropometric analysis included age, sex, height, and weight. Body mass index (BMI) was calculated using the height and weight of the participant; BMI > 25 was considered “overweight and obese,” 18.5–25 as “normal weight,” and < 18.5 as “underweight.”

Sleep quality was assessed using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI).<sup>14,15</sup> This scale consists of 18 questions about sleep habits during the previous month. From these questions, seven component scores were calculated: “sleep quality,” “sleep latency,” “sleep duration,” “habitual sleep efficiency,” “sleep disturbances,” “use of sleep medication,” and “daytime dysfunction.” Each component was on a scale of 0–3 points, with higher scores indicating poorer sleep conditions. The global PSQI score was 0–21 points, and scores > 5 points indicated “poor sleep quality” (when used to screen insomnia, the sensitivity was 85.7%, while the specificity was 86.6%<sup>15</sup>).

Lifestyle habits included sleep, smoking, drinking alcohol, meals, part-time job, and use of electronics after lights out. Items regarding sleep included bedtime and wake-up time during the past month, respectively. For smoking,

respondents were asked whether they currently smoke habitually. Similarly, for drinking alcohol, respondents were asked whether they habitually drank alcohol. Regarding meals, regularity of mealtimes (whether or not they are eating at regular times) and the number of days they skipped breakfast, lunch, and dinner per week, respectively, were asked. Furthermore, the frequency of meals, alcoholic drinks, caffeinated drinks, and supplements before going to bed were rated on a 6-point scale as “every day,” “5 to 6 days per week,” “3 to 4 days per week,” “1 to 2 days per week,” “1 to 3 days per month,” or “never.” Regarding part-time jobs, we first asked whether they currently have part-time jobs, then those who have part-time jobs were asked if they worked during late night hours (11:00 PM–6:00 AM). Finally, respondents were asked whether they used the television, smartphone/cellphone, computer, and gaming devices after lights out.

Regarding competition-based activities, activity contents and competition stressors were asked. For activity contents, the survey asked about sports duration per week (minutes), the number of morning practice (before 9:00 AM) per week, and the number of evening practice (after 9:00 PM) per week. For competition stressors, we used the Competition Stressor Scale developed by Asanuma et al.<sup>16</sup> This 28-item scale measured the frequency of exposure to stressors related to competitive activities over the past month. Each item was rated on a 4-point scale, with 0 indicating “not at all” and 3 indicating “very often.” This scale comprised 5 factors, and the score range for each component is as follows: “interpersonal relationships,” 0–24 points; “competition results,” 0–9 points; “evaluations from one’s surroundings,” 0–15 points; “expectations and pressure from others,” 0–15 points; and “motivation loss,” 0–21 points. Higher scores indicated higher stress levels. The relevance of this scale has been shown by previous studies<sup>16</sup>; the Cronbach  $\alpha$  values for our respondents were: interpersonal relationships, 0.88 and 0.89 in 2020 and 2021, respectively; competition results, 0.89 and 0.88 in 2020 and 2021, respectively; evaluations from one’s surroundings, 0.84 and 0.79 in 2020 and 2021, respectively; expectations and pressure from others, 0.88 in 2020 and 0.83 in 2021; and motivation loss, 0.87 and 0.89 in 2020 and 2021, respectively.

The Japanese version of the K6 scale assessed psychological distress<sup>17</sup> and is robust for screening this condition.<sup>18</sup> All 6 items were rated on a 5-point Likert scale, with scores of 0 to 4 points, and a higher score indicated poor mental health condition. The cutoff value was 5 points, and a score of  $\geq 5$  points indicated “psychological distress” (when used to screen mood and anxiety disorders, the sensitivity was 100.0%, while the specificity was 68.7%<sup>19</sup>). The Japanese version of the K6 distress scale was validated,<sup>19</sup> and the internal consistency reliability (Cronbach  $\alpha$ ) of the scale in the present study was 0.87 and 0.92 in 2020 and 2021, respectively.

### Statistical Analysis

First, the global PSQI score and the prevalence of poor sleep quality (scores  $> 5$  points) in 2020 and 2021 were compared

using the Fisher exact test and the *t*-test. Second, to compare risk factors of poor sleep quality between two time points, univariate and multivariate logistic regression analyses were performed with sleep quality as the objective variable and lifestyle habits, competition-based activities, and psychological distress as the explanatory variables in 2020 and 2021, respectively. Multivariate logistic regression analysis adjusted for age, sex, and BMI, and prior to this analysis, we confirmed that multicollinearity did not occur.

In logistic regression analyses, regarding sleep quality, “good” ( $\leq 5$  points in the PSQI) was coded as “0,” while “poor” ( $> 5$  points in the PSQI) was coded as “1.” Bedtime was divided into four groups, “before 11:00 p.m.,” “11:00–11:59 p.m.,” “12:00–12:59 a.m.,” and “after 1:00 a.m.”; wake-up time was divided into four groups, “before 6:00 a.m.,” “6:00–6:59 a.m.,” “7:00–7:59 a.m.,” and “after 8:00 a.m.” Part time job was categorized as “no,” “yes (no late night),” and “yes (late night).” The number of morning and evening practices per week were divided into three groups, “0 days,” “1 to 3 days,” and “4 to 7 days.” Sports duration per week and competition stressors were quantitative variables. Other independent variables were dichotomously categorized as yes/no.

IBM SPSS Statistics for Windows 25.0J (IBM Corp., Armonk, NY, USA) was used for all statistical analyses, and statistical significance was set at 5%.

## Results

► **Table 1** presents the respondents’ anthropometric analysis, sleep quality, lifestyle habits, competition-based activities, and psychological distress. The mean age was  $19.7 \pm 0.9$  years old in 2020 and  $19.8 \pm 0.8$  years old in 2021. The proportion of males was 68.5% in 2020 and 68.8% in 2021. Regarding BMI, 1.9% were underweight, 80.7% were normal weight, and 17.4% were overweight and obese in 2020; 3.4% were underweight, 78.3% were normal weight, and 18.3% were overweight and obese in 2021. There was no significant difference in sex ratio and mean age between both surveys. Bedtime and wake-up time were significantly earlier in 2021 than in 2020.

The prevalence of poor sleep quality did not differ significantly between both surveys (33.6 and 36.6% in 2020 and 2021, respectively). However, the global PSQI score was significantly higher in 2021 ( $4.9 \pm 2.5$ ) than in 2020 ( $4.6 \pm 2.5$ ) ( $p = 0.008$ ).

► **Table 2** presents the results of the logistic regression analysis in 2020. In the univariate analysis, most variables had significant relationships with poor sleep quality: bedtime, regularity of mealtimes, skipping breakfast, skipping lunch, skipping dinner, taking meals before bed, taking caffeinated drinks before bed, part-time jobs, use of smartphone/cellphone after lights out, use of the computer after lights out, use of gaming devices after lights out, sports duration per week, number of evening practices per week, five types of competition stressors, and psychological distress.

The multivariate analysis revealed that poor sleep quality had a significant relation to bedtime, taking supplements

**Table 1** Characteristics of the Respondents.

		2020	2021	
		(n = 961)	(n = 711)	
		Mean ± SD or n (%)	Mean ± SD or n (%)	p-value
Anthropometric analysis				
Age (years old)		19.7 ± 0.9	19.8 ± 0.8	0.229 <sup>a</sup>
Sex	Male	658 (68.5)	489 (68.8)	0.915 <sup>b</sup>
	Female	303 (31.5)	222 (31.2)	
Body mass index	Underweight	18 (1.9)	24 (3.4)	0.133 <sup>b</sup>
	Normal weight	776 (80.7)	557 (78.3)	
	Overweight and obese	167 (17.4)	130 (18.3)	
Global PSQI Score		4.6 ± 2.5	4.9 ± 2.5	0.008 <sup>a</sup>
Sleep quality	Poor	323 (33.6)	260 (36.6)	0.213 <sup>b</sup>
Lifestyle habits				
Sleep				
Bedtime		0:27 ± 1:13	0:19 ± 1:09	0.022 <sup>a</sup>
Wake-up time		8:20 ± 1:28	7:46 ± 1:23	< 0.001 <sup>a</sup>
Smoking	Yes	32 (3.3)	18 (2.5)	0.385 <sup>b</sup>
Drinking alcohol	Yes	296 (30.8)	206 (29.0)	0.450 <sup>b</sup>
Meals				
Regularity of mealtimes	Yes	719 (74.8)	513 (72.2)	0.238 <sup>b</sup>
Skipping breakfast	Yes	491 (51.1)	367 (51.6)	0.843 <sup>b</sup>
Skipping lunch	Yes	177 (18.4)	127 (17.9)	0.798 <sup>b</sup>
Skipping dinner	Yes	73 (7.6)	80 (11.3)	0.013 <sup>b</sup>
Taking meals before bed	Yes	504 (52.4)	456 (64.1)	< 0.001 <sup>b</sup>
Taking alcoholic drinks before bed	Yes	241 (25.1)	144 (20.3)	0.022 <sup>b</sup>
Taking caffeinated drinks before bed	Yes	367 (38.2)	271 (38.1)	1.000 <sup>b</sup>
Taking supplements before bed	Yes	320 (33.3)	301 (42.3)	< 0.001 <sup>b</sup>
Part-time job	Yes (no late night)	375 (39.0)	365 (51.3)	< 0.001 <sup>b</sup>
	Yes (late night)	84 (8.7)	83 (11.7)	
Use of electronics after lights out				
Television	Yes	77 (8.0)	50 (7.0)	0.514 <sup>b</sup>
Smartphone/cellphone	Yes	627 (65.2)	464 (65.3)	1.000 <sup>b</sup>
Computer	Yes	28 (2.9)	31 (4.4)	0.140 <sup>b</sup>
Gaming devices	Yes	77 (8.0)	49 (6.9)	0.401 <sup>b</sup>
Competition-based activities				
Sports duration per week (minutes)		383.8 ± 311.9	954.1 ± 569.2	< 0.001 <sup>a</sup>
Number of morning practices per week	0 days	691 (71.9)	361 (50.8)	< 0.001 <sup>b</sup>
	1–3 days	152 (15.8)	229 (32.2)	
	4–7 days	118 (12.3)	121 (17.0)	
Number of evening practices per week	0 days	759 (79.0)	514 (72.3)	0.002 <sup>b</sup>
	1–3 days	141 (14.7)	124 (17.4)	
	4–7 days	61 (6.3)	73 (10.3)	
Competition stressors				
Interpersonal relationships		2.2 ± 3.5	3.9 ± 4.5	< 0.001 <sup>c</sup>

(Continued)

**Table 1** (Continued)

		2020	2021	
		(n = 961)	(n = 711)	
		Mean ± SD or n (%)	Mean ± SD or n (%)	<i>p</i> -value
Competition results		2.9 ± 2.9	3.9 ± 2.9	< 0.001 <sup>c</sup>
Evaluations from one's surroundings		3.3 ± 3.8	4.1 ± 3.6	< 0.001 <sup>c</sup>
Expectations and pressure from others		2.6 ± 3.3	3.2 ± 3.3	< 0.001 <sup>c</sup>
Motivation loss		4.3 ± 4.7	5.3 ± 5.1	< 0.001 <sup>c</sup>
Psychological distress	Yes	182 (18.9)	164 (23.1)	0.044 <sup>b</sup>

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation.

<sup>a</sup>t-test.

<sup>b</sup>Fisher exact test.

<sup>c</sup>Mann-Whitney U test.

before bed, part-time job (no late night), stressors of expectations and pressure from others, and psychological distress. Late bedtime indicated higher odds of poor sleep quality; "after 1:00 a.m." had significantly higher odds compared with "before 11:00 p.m.," (odds ratio [OR]: 5.13; 95% confidence interval [CI]: 1.92–13.70,  $p < 0.01$ ). In addition, respondents taking supplements before bed had significantly higher odds of poor sleep quality compared with those that were not (OR: 1.49; 95% CI: 1.07–2.07,  $p < 0.05$ ), and as did those working part-time jobs (no late time) compared with those without part-time jobs (OR: 1.38; 95%CI: 1.00–1.91;  $p < 0.05$ ). A higher score of stressors of expectations and pressure from others increased the odds ratio of poor sleep quality (OR: 1.08; 95%CI: 1.02–1.14;  $p < 0.01$ ). Furthermore, psychological distress also had significantly higher odds than in its absence (OR: 3.04; 95%CI: 2.07–4.46;  $p < 0.001$ ).

► **Table 3** presents the results of logistic regression analysis in 2021. In the univariate analysis, poor sleep quality was related to bedtime, wake-up time, drinking alcohol, regularity of mealtimes, skipping breakfast, skipping lunch, skipping dinner, taking meals before bed, taking alcoholic drinks before bed, taking caffeinated drinks before bed, use of smartphone/cellphone after lights out, five types of competition stressors, and psychological distress.

The multivariate analysis revealed that poor sleep quality had significant relationships with wake-up time, skipping breakfast, taking caffeinated drinks before bed, use of smartphone/cellphone after lights out, stressors of motivation loss, and psychological distress. Regarding wake-up time, "before 6:00 a.m." (OR: 4.37; 95% CI: 1.81–10.52;  $p < 0.01$ ) and "6:00–6:59 a.m." (OR: 3.21; 95%CI: 1.74–5.92;  $p < 0.001$ ) indicated significantly higher odds of causing poor sleep quality compared with "after 8:00 a.m." There were significantly higher odds of poor sleep quality among respondents skipping breakfast than those who were not (OR: 1.56; 95%CI: 1.04–2.35;  $p < 0.05$ ). In addition, respondents taking caffeinated drinks before bed had a significantly higher OR compared with those not taking them (OR: 1.55; 95%CI: 1.04–2.30;  $p < 0.05$ ), as did those using

smartphones/cellphones after lights out compared with those who did not use them (OR: 2.68; 95%CI: 1.74–4.15;  $p < 0.001$ ). A higher score of stressors of motivation loss increased the OR of poor sleep quality (OR: 1.05; 95%CI: 1.00–1.11;  $p < 0.05$ ). Furthermore, psychological distress also had significantly higher odds than in its absence (OR: 3.33; 95%CI: 2.11–5.25;  $p < 0.001$ ).

## Discussion

The present study investigated the prevalence and risk factors of poor sleep quality in Japanese student-athletes in the initial pandemic period (2020) and a year after the pandemic began (2021). First, our study observed that the prevalence of poor sleep quality assessed using the PSQI had no significant difference between two time points: 33.6 and 36.6% in 2020 and 2021, respectively. Since the prevalence in both time points was significantly lower than 45.6% in a previous study before the pandemic,<sup>13</sup> it is considered that sleep conditions of Japanese student-athletes during the pandemic (2020–2021) was better than before the pandemic. On the other hand, global PSQI scores were significantly lower in 2020 than in 2021. Therefore, it is possible that sleep conditions of student-athletes were even better in the initial pandemic period in 2020. This result was consistent with some previous studies, reporting that university students in Saudi Arabia experienced improved sleep quality during lockdown (June 2020) than prelockdown (March 2020)<sup>20</sup> and that the prevalence of insomnia symptoms in Japanese students (mean age: 18.4 years old) was lower during the pandemic period (May 2020) than before the pandemic (October 2019).<sup>8</sup> The situation surrounding student-athletes has yet to return to the prepandemic levels ultimately. However, recent restrictions on competition-based activities and daily life are lesser than in 2020. In fact, morning and evening practices were more frequent in 2021 than in 2020, and this result might be responsible for the difference in global PSQI scores. The prevalence of poor sleep quality among student-athletes could return to prepandemic levels

**Table 2** Logistic regression analysis of poor sleep quality in 2020

		Univariate			Multivariate		
		OR	95% CI	p-value	OR	95% CI	p-value
Lifestyle habits							
Sleep							
Bedtime	(Ref: Before 11:00 PM)	2.06	0.87-4.86	0.099	1.94	0.74-5.07	0.175
	11:00-11:59 PM						
	(Ref: Before 12:59 AM)	2.34	1.02-5.36	0.046	2.24	0.86-5.81	0.099
	12:00-12:59 AM						
	(Ref: After 1:00 AM)	5.69	2.49-13.01	<0.001	5.13	1.92-13.70	0.001
	After 1:00 AM						
Wake-up time	(Ref: After 8:00 AM)	0.48	0.19-1.19	0.114	1.04	0.35-3.11	0.945
	Before 6:00 AM						
	(Ref: 6:00-6:59 am)	0.96	0.58-1.58	0.859	1.57	0.85-2.92	0.154
	6:00-6:59 am						
	(Ref: 7:00-7:59 am)	0.78	0.55-1.10	0.153	1.39	0.92-2.10	0.123
	7:00-7:59 am						
Smoking	(Ref: no)	1.04	0.49-2.18	0.926	0.87	0.38-2.02	0.748
	Yes						
Drinking alcohol	(Ref: no)	0.91	0.68-1.21	0.507	0.67	0.43-1.05	0.079
	Yes						
Meals							
Regularity of mealtimes	(Ref: yes)	1.68	1.24-2.27	<0.001	1.15	0.80-1.66	0.447
	No						
Skipping breakfast	(Ref: no)	1.87	1.42-2.45	<0.001	1.30	0.93-1.83	0.128
	Yes						
Skipping lunch	(Ref: no)	2.06	1.48-2.87	<0.001	1.41	0.94-2.12	0.096
	Yes						
Skipping dinner	(Ref: no)	2.04	1.26-3.29	0.004	1.45	0.80-2.60	0.218
	Yes						
Taking meals before bed	(Ref: no)	1.42	1.08-1.86	0.011	1.07	0.76-1.49	0.714
	Yes						
Taking alcoholic drinks before bed	(Ref: no)	1.08	0.79-1.46	0.637	0.92	0.57-1.48	0.726
	Yes						
Taking caffeinated drinks before bed	(Ref: no)	1.39	1.05-1.82	0.019	1.06	0.75-1.49	0.742
	Yes						
Taking supplements before bed	(Ref: no)	1.32	1.00-1.75	0.052	1.49	1.07-2.07	0.019
	Yes						
Part-time job	(Ref: no)	1.42	1.08-1.89	0.014	1.38	1.00-1.91	0.047
	Yes (no late night)						
	Yes (late night)	0.90	0.54-1.51	0.698	0.83	0.46-1.48	0.519
Use of electronics after lights out							
Television	(Ref: no)	1.14	0.70-1.85	0.594	1.13	0.65-1.95	0.663
	Yes						
Smartphone/cellphone(Ref: no)	Yes	1.40-2.52	<0.001	1.40	0.99-1.98	0.055	

(Continued)

**Table 2** (Continued)

			Univariate			Multivariate		
			OR	95% CI	p-value	OR	95% CI	p-value
Computer	(Ref: no)	Yes	2.34	1.10-4.98	0.027	1.40	0.58-3.36	0.450
Gaming devices	(Ref: no)	Yes	1.72	1.08-2.76	0.023	1.34	0.80-2.26	0.271
Competition-based activities								
Activity contents								
Sports time per week			0.97	0.95-1.00	0.029	0.98	0.95-1.01	0.276
Number of morning practices per week	(Ref: 0 days)	1-3 days	1.10	0.76-1.59	0.609	1.00	0.65-1.53	0.996
		4-7 days	0.75	0.49-1.16	0.198	0.96	0.56-1.64	0.888
Number of evening practices per week	(Ref: 0 days)	1-3 days	1.48	1.03-2.14	0.036	1.06	0.69-1.62	0.803
		4-7 days	1.20	0.69-2.06	0.516	1.05	0.57-1.94	0.883
Competition stressors								
Interpersonal relationships			1.07	1.03-1.11	<0.001	1.00	0.95-1.05	0.962
Competition results			1.11	1.06-1.16	<0.001	1.06	0.99-1.13	0.107
Evaluations from one's surroundings			1.05	1.02-1.09	0.003	0.98	0.93-1.03	0.386
Expectations and pressure from others			1.10	1.06-1.15	<0.001	1.08	1.02-1.14	0.008
Motivation loss			1.06	1.03-1.09	<0.001	0.99	0.95-1.03	0.691
Psychological distress	(Ref: No)	Yes	3.72	2.66-5.19	<0.001	3.04	2.07-4.46	<0.001

Abbreviations: CI, confidence interval; OR, odds ratio. Adjusted for age, sex, and body mass index.

**Table 3** Logistic regression analysis of poor sleep quality in 2021.

		Univariate			Multivariate		
		OR	95% CI	p-value	OR	95% CI	p-value
Lifestyle habits							
Sleep							
Bedtime	(Ref: Before 11:00 PM)	1.18	0.53-2.62	0.692	1.76	0.64-4.79	0.271
	11:00-11:59 PM						
	(Ref: Before 11:00 PM)	1.29	0.60-2.78	0.521	1.95	0.71-5.36	0.196
	12:00-12:59 AM						
	(Ref: After 8:00 AM)	2.27	1.04-4.93	0.038	2.72	0.94-7.84	0.064
	After 1:00 AM						
Wake-up time	(Ref: After 8:00 AM)	2.06	1.19-3.60	0.010	4.37	1.81-10.52	0.001
	Before 6:00 AM						
	(Ref: no)	1.76	1.12-2.75	0.013	3.21	1.74-5.92	< 0.001
	6:00-6:59 AM						
	(Ref: no)	0.74	0.51-1.09	0.124	1.08	0.67-1.75	0.742
	7:00-7:59 AM						
Smoking	(Ref: no)	1.40	0.55-3.59	0.484	1.37	0.44-4.26	0.591
	Yes						
Drinking alcohol	(Ref: no)	1.87	1.34-2.60	< 0.001	1.27	0.72-2.24	0.414
	Yes						
Meals							
Regularity of mealtimes	(Ref: yes)	2.00	1.43-2.80	< 0.001	1.21	0.79-1.84	0.377
	No						
Skipping breakfast	(Ref: no)	1.93	1.42-2.64	< 0.001	1.56	1.04-2.35	0.032
	Yes						
Skipping lunch	(Ref: no)	2.45	1.66-3.61	< 0.001	1.37	0.83-2.27	0.216
	Yes						
Skipping dinner	(Ref: no)	2.64	1.64-4.23	< 0.001	1.17	0.62-2.22	0.624
	Yes						
Taking meals before bed	(Ref: no)	1.39	1.00-1.92	0.047	0.92	0.61-1.40	0.713
	Yes						
Taking alcoholic drinks before bed	(Ref: no)	2.02	1.39-2.92	< 0.001	0.95	0.50-1.81	0.868
	Yes						
Taking caffeinated drinks before bed	(Ref: no)	1.93	1.41-2.65	< 0.001	1.55	1.04-2.30	0.033
	Yes						
Taking supplements before bed	(Ref: no)	0.97	0.71-1.33	0.866	1.04	0.70-1.54	0.844
	Yes						
Part-time job	(Ref: no)	0.82	0.59-1.14	0.235	0.71	0.47-1.07	0.099
	Yes (no late night)						
	Yes (late night)	1.38	0.84-2.27	0.209	0.85	0.45-1.59	0.602
Use of electronics after lights out							
Television	(Ref: no)	1.28	0.71-2.29	0.409	0.92	0.45-1.90	0.828
	Yes						
Smartphone/cellphone	(Ref: no)	2.36	1.67-3.33	< 0.001	2.68	1.74-4.15	< 0.001
	Yes						
Computer	(Ref: no)	1.10	0.53-2.30	0.800	0.64	0.25-1.61	0.341
	Yes						
Gaming devices	(Ref: no)	1.59	0.89-2.84	0.121	1.18	0.57-2.43	0.661
	Yes						

(Continued)



**Table 3** (Continued)

		Univariate			Multivariate		
		OR	95% CI	p-value	OR	95% CI	p-value
Competition-based activities							
Activity contents							
Sports time per week		0.99	0.97–1.01	0.274	0.98	0.96–1.00	0.059
Number of morning practices per week	(Ref: 0 days)	1.00	0.70–1.41	0.983	1.08	0.70–1.67	0.732
	1–3 days	1.33	0.87–2.02	0.188	0.99	0.52–1.86	0.968
	4–7 days	1.30	0.87–1.94	0.205	1.32	0.81–2.15	0.264
Number of evening practices per week	(Ref: 0 days)	1.22	0.74–2.02	0.432	1.13	0.61–2.12	0.693
	1–3 days						
	4–7 days						
Competition stressors							
Interpersonal relationships		1.11	1.07–1.14	< 0.001	1.00	0.95–1.05	0.859
Competition results		1.15	1.09–1.22	< 0.001	1.01	0.93–1.09	0.804
Evaluations from one's surroundings		1.15	1.10–1.21	< 0.001	1.06	0.99–1.13	0.081
Expectations and pressure from others		1.15	1.10–1.20	< 0.001	1.06	0.99–1.14	0.102
Motivation loss		1.13	1.10–1.17	< 0.001	1.05	1.00–1.11	0.036
Psychological distress	(Ref: No)	4.83	3.33–7.01	< 0.001	3.33	2.11–5.25	< 0.001
	Yes						

Abbreviation: CI, confidence interval; OR, odds ratio. Adjusted for age, sex, and body mass index.

hereafter; therefore, preserving their good sleep conditions is vital.

Second, regarding risk factors of poor sleep quality in student-athletes in 2020 and 2021, the multiple logistic regression analysis revealed that psychological distress was a common risk factor in 2020 and 2021. Since this is also a common factor in the pre-pandemic periods,<sup>13</sup> it is suggested that psychological distress is a primary risk factor for poor sleep quality in student-athletes regardless of the COVID-19 pandemic. Therefore, mental health promoting measures are essential for preventing poor sleep quality in student-athletes. On the other hand, except for psychological distress, all the risk factors for poor sleep quality in student-athletes differed between 2020 and 2021.

In 2020, late bedtime, taking supplements before bed, working part-time jobs (no late time), and competition stressors of expectations and pressure from others were significantly related to poor sleep quality. These risk factors, except late bedtime, were not consistent with pre-pandemic study results.<sup>13</sup> Most related factors of poor sleep quality in the initial pandemic period may be specifically due to the dramatic change in the daily life of student-athletes. For instance, taking supplements before bedtime puts a strain on gastrointestinal function and negatively impacts sleep because physical activities decreased during the COVID-19 home confinement period.<sup>21</sup> Daytime part-time jobs possibly reduced lifetime and negatively affected sleep because most universities had transitioned to online classes, and students had many assignments in 2020.<sup>22,23</sup> In contrast, part-time jobs at late night were related to poor sleep quality before the pandemic<sup>13</sup>; such a relationship was not observed in 2020 because few student-athletes had part-time jobs late at night. Also, competition stressors of expectations and pressure from others such as parents, teammates, coaches, and rivals<sup>16</sup> were significantly related to poor sleep quality of student-athletes in 2020, possibly because they were compelled to suspend their sports activities, restrict the use of training facilities, and postpone or cancel the competitions in the initial pandemic period.<sup>1,2</sup>

In 2021, early wake-up time, skipping breakfast, taking caffeinated drinks before bed, use of smartphone/cellphone after lights out, and stressors of motivation loss were significantly related to poor sleep quality. Of these, early wake-up time, use of smartphone/cellphone after lights out, and stressors of motivation loss such as “I lost my confidence in competing,” “I was dissatisfied with the practice contents,” and “the practice contents were not fun”<sup>16</sup> were consistent with pre-pandemic study results.<sup>13</sup> Since athletic activities such as daily practice and competitions have gradually resumed with infection control measures<sup>3,4</sup> from 2021, factors related to poor sleep quality in 2021 might have become like those in the pre-pandemic period. Based on situations where competitive activities were returning to the pre-pandemic statuses, it is necessary to examine measures improving these risk factors. Furthermore, skipping breakfast and taking caffeinated drinks before bed were related to poor sleep quality in 2021. Particularly, more student-athletes skipped breakfast during the pandemic

than in pre-pandemic periods,<sup>13</sup> and thus, it is important to improve such eating habits in the future.

The present study had several limitations. First, the study used cross-sectional data; thus, we cannot evaluate the causal relationship between poor sleep quality and lifestyle habits, competition-based activities, and psychological distress. A longitudinal study is necessary to verify the causal relationship among these variables. Second, the two surveys in the present study were not conducted with the same student-athletes, and the survey in 2021 did not include questions about the changes in lifestyle habits as well as competition-based activities between 2020 and 2021. Although the study populations of two time points were matched for age, sex, and universities they belong to, interpreting the comparisons of prevalence and risk factors of poor sleep quality between two time points should be carefully considered. Third, data were collected via self-reported questionnaires; therefore, reporting bias for sleep and competitive activity situations cannot be ruled out. In the future, sleep and competition activities should be surveyed using an objective measuring method, such as an accelerometer.

Despite these limitations, this is a valuable study as it clarified the prevalence of poor sleep quality and its risk factors in student-athletes during the COVID-19 pandemic, with comparison between 2020 and 2021. Our study respondents are highly representative of Japanese student-athletes because they belong to the faculties of six universities of Physical Education from four Japanese regions. The COVID-19 pandemic has been going on for a while, and people in some regions are still forced to refrain from activities. Our findings will contribute to examining measures for preventing poor sleep quality of student-athletes during the pandemic.

## Conclusions

In both the initial COVID-19 pandemic (2020) and 1 year after the pandemic began (2021), one-third of student-athletes had poor sleep quality and psychological distress was its common risk factor. However, lifestyle habits and competition stressors which were risks factors for poor sleep quality were different from the previous year: those tended to be specific under pandemic such as late bedtime, taking supplements before bed, part-time job (no late night), stressors of expectations and pressure from others in 2020, while those tended to be like prior to the pandemic, such as early wake-up time, skipping breakfast, taking caffeinated drinks before bed, use of smartphone/cellphone after lights out, and stressors of motivation loss in 2021.

### Funding Source

The present study was supported in part by a grant from Advanced Research Initiative for Human High Performance (ARIHHP), University of Tsukuba.

### Conflict of Interests

The authors have no conflict of interests to disclose.

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